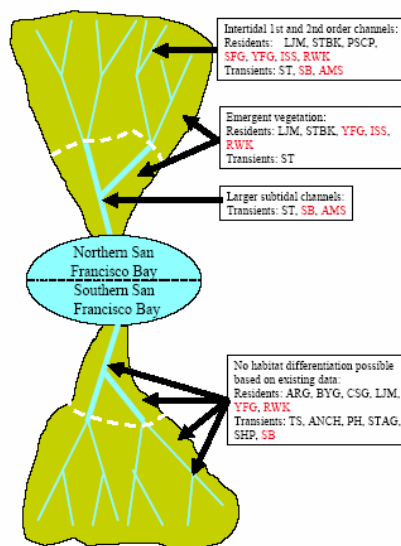# Conceptual Models

Prepared by Dennis D. Murphy, University of Nevada, Reno

Conceptual models are critical to the development of assessment and monitoring programs. Conceptual models document the specific version of our hypotheses about how ecological systems function. Conceptual models describe in graphical or narrative form the ecological system subject to management, allowing inference about how that system "works." Such models help to clarify our verbal descriptions of what we have observed in nature, and force us to think about ecosystem elements and interactions that we might otherwise ignore. The formulation of a model naturally leads to the identification of parameters that will need to be measured by monitoring. In the formulation of a conceptual model the combinations of parameters that drive ecological systems often become apparent, which in turn allows us to rank the importance of different attributes in determining system function.

The term model should not cause proposal anxiety. In requiring conceptual models the program is simply asking for a clear articulation of what is known about the ecological system that will be subject to assessment and monitoring – an explicit description of how the proposers believe their study system operates. The conceptual model should clearly identify key system elements, including the species involved, ecosystem structure, and the processes that link species with other biotic and physical elements in the system.

A model of physical and biotic process at the scale of the Bay and Delta might look like –

A conceptual model for fish habitat use in San Francisco Bay tidal wetlands. Species codes in red indicate alien species. Species codes: AMS–American shad; ANCH–northern anchovy; ARG–arrow goby; BYG–bay goby; CSG–cheekspot goby; ISS–inland silverside; LJM–longjaw mudsucker; PH–Pacific herring; PSCP–prickly sculpin; RWK–rainwater killifish; SB–striped bass; SFG–shimofuri goby; SHP–shinerperch; ST–splittail; STAG–Pacific staghorn sculpin; STBK–threespine stickleback; TS–topsmelt; YFG–yellowfin goby. (from Larry R. Brown. 2003. Will Tidal Wetland Restoration Enhance Populations

A biological and biochemical process model might appear as –
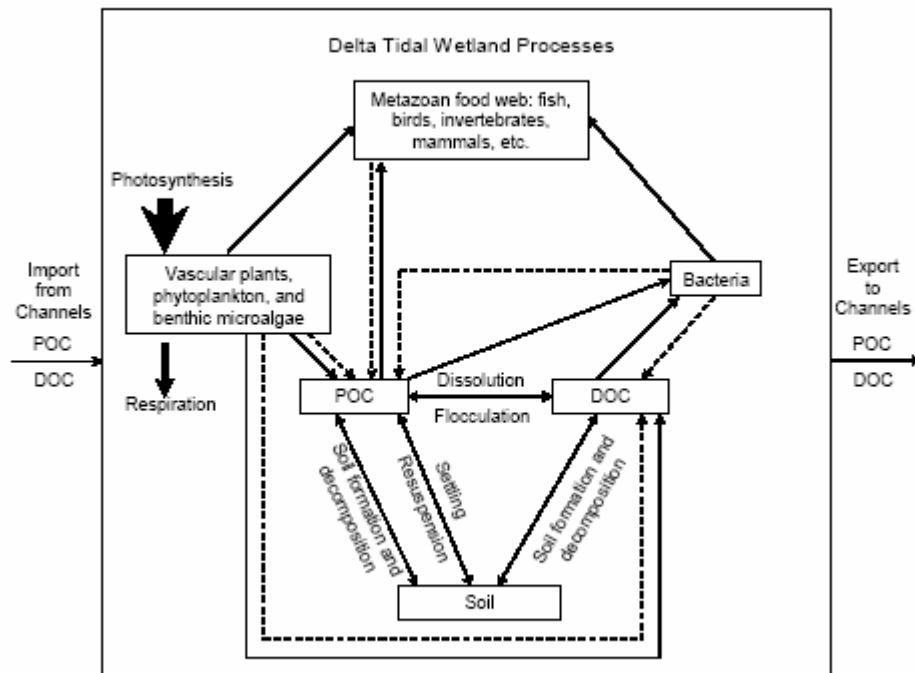
Basic conceptual model for the production and transfer of organic carbon between various pools (indicated by boxes) of organic carbon within the Sacramento-San Joaquin Delta tidal wetlands (adapted from Jassby and Cloern 2000). Solid arrows indicate transfers of material or energy. Dotted arrows indicatetransfers resulting from microbial decomposition. Processes within pools of carbon, such as photolysis and hydrolysis within the DOC pool, are not shown. (POC, particulate organic carbon; DOC, dissolved organic carbon). From Larry R. Brown. 2003. Potential E_ects of Organic Carbon Production on Ecosystems and Drinking Water Quality In: Larry R. Brown, editor. Issues in San Francisco Estuary Tidal Wetlands Restoration. San Francisco Estuary and Watershed Science. Vol. 1, Issue 1 (October 2003), Article 3. http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art3.

Illustrations of chemical cycles are conceptual models –

Figure 4-3. SBSP Conceptual Model for Mercury Cycling
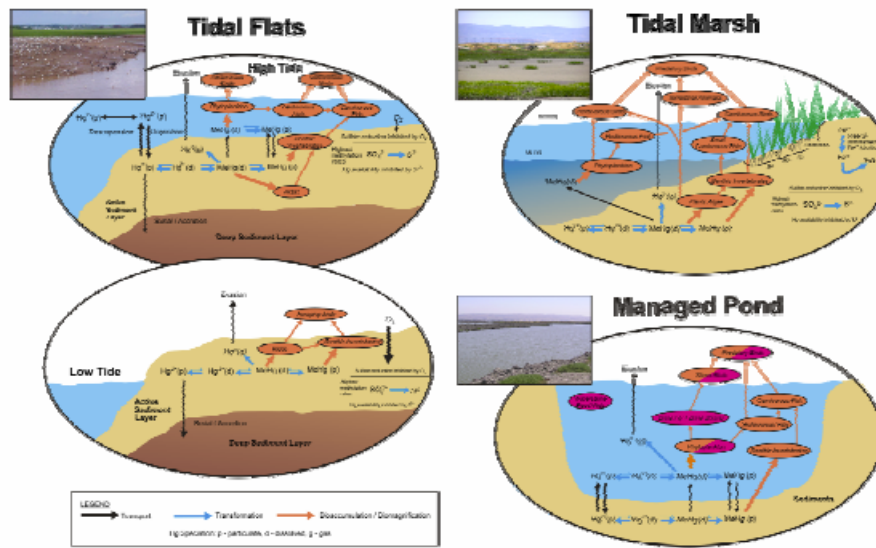
South Bay Salt Ponds Restoration Project –Mercury Technical Memorandum
8/4/2004
1720.03

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From "Mercury Technical Memorandum – Final Draft". South Bay Salt Ponds Restoration Project.
http://www.southbayrestoration.org/pdf_files/Final%20BC%20Mercury%20Technical%20Memo%20Aug
%204%202004.pdf

A foodweb can serve as a conceptual model; this nested graphic shows the complexity of
adjacent and interacting ecological communities --
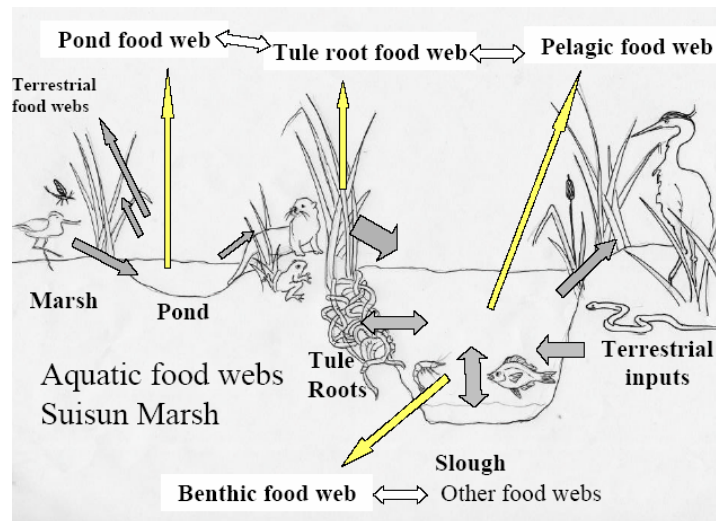
By Peter Moyle for San Francisco Bay-Delta Science Consortium's 2004 **Suisun Marsh Workshop**
http://www.baydeltaconsortium.org/downloads/pdf/Moyle4_Food_Web_Diagrams.pdf

A narrative conceptual model accompanied by a map or diagram of the positions of
landscape features, resources, and species of concern may serve well –

The Dutch Slough restoration project will create a mosaic of natural wetland habitat types along a gradient from dendritic tidal marsh to
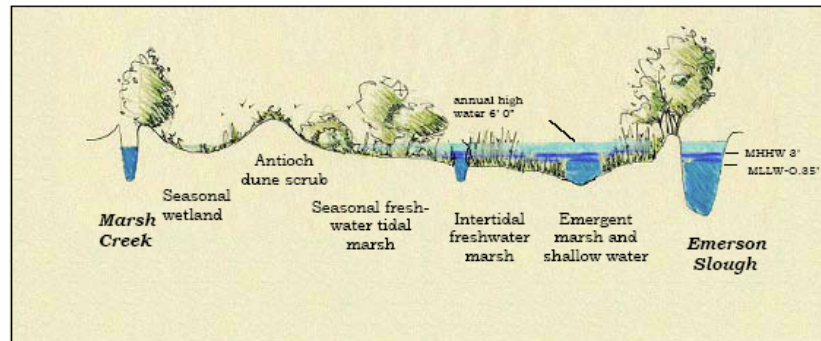

Figure 5: Representative cross section of restored Emerson parcel.

seasonally inundated floodplain and riparian forest. Daily fluctuations of the tides, winter flooding, and seasonal variations in salinity will favor native fish and the macroinvertebrates they feed upon by creating habitat niches that are not subject to colonization by exotic predators or invasive aquatic vegetation. The daily and seasonal cycles of wetting and drying combined with the spatial complexity of dendritic tidal marsh and riparian habitats provide essential refuge and feeding opportunities during critical early life stages of endangered transient and anadromous fish when they are both growing and vulnerable to predation. The site's location at the mouth of Marsh Creek and in the western portion of the Delta where the tidal range and salinity fluctuation is greater will accentuate this spatial and temporal diversity. The site's proximity to the confluence of the Sacramento and San Joaquin Rivers and its relatively good connectivity to Suisun Marsh along a corridor of wetland sites[1] increases the probability that native fish will utilize the site.

From "Dutch Slough Tidal Marsh Restoration Project", a 2003 proposal of the State Coastal Conservancy to the California Bay-Delta Authority
http://calwater.ca.gov/Programs/EcosystemRestoration/2002_Proposals/Dutch%20Slough%20Revision%20Final_30DA.pdf

The conceptual model should clearly identify areas of uncertainty; identify what we do not know as well as what we know about the system, and the sources of accepted knowledge from the literature. Include available data in your explanations if they are useful in illustrating relationships and other points. And, make sure to identify limiting factors to ecosystem processes, population sizes, or other system attributes.

* * *